INTERDEPARTMENTAL
ACTION PLAN
TO FAVOUR

the survival
OF THE ST. LAWRENCE
beluga whale

ANNUAL REPORT
1992-1993

Fisheries and Oceans
Pêches et Océans
Environment Canada
Environnement Canada

ST. LAWRENCE ACTION PLAN

Canada

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The Honourable Ross Reid
Minister of Fisheries and Oceans

The Honourable Pierre H. Vincent
Minister of the Environment

Dear Sirs:

We have the honour to submit the fifth annual report of the *Interdepartmental Action Plan to Favour the Survival of the St. Lawrence Beluga*. This report summarizes the main results achieved by your respective departments, under the Action Plan, during the 1992-1993 fiscal year.

The Action Plan comprises four major themes with specific objectives: **increasing our knowledge** of the species and its habitat in order to set priorities for action to protect the whale population; **controlling disturbances** and **reducing toxic substances** in the environment in order to act on the factors that limit population growth; and finally, **communicating information** in order to increase public awareness of the need for conservation of the beluga and of the whole St. Lawrence River ecosystem.

Most of the projects initiated in the course of the Action Plan were concluded during 1992-1993; some will continue as part of a long-term monitoring program. The main results indicate that the beluga population remains stable at about 500 individuals but its summer distribution has been found to extend further downstream than previously known, reaching from Ile aux Coudres to Rivière Portneuf and to the Bic Islands. A promising method to detect potential harassment factors is the analysis of beluga vocalizations; the sound frequency used by belugas is indicative of their level of stress. Toxicological analyses have shown that the American eel is the main source of contaminants for the beluga, with eels from the Great Lakes accounting for more than half of all toxic substances found in belugas. Finally, a natural resource conservation unit for the Saguenay Marine Park was established, working in close collaboration with DFO protection officers; it resulted in a greater level of surveillance and more efficient control of harassment by vessel traffic and private yachts.

We hope that this report will meet your expectations and those of the public, so that action to ensure the survival of the beluga and to protect the St. Lawrence ecosystem may be further pursued.

Respectfully yours,

JACQUE ROBICHAUD
Acting Regional Director General
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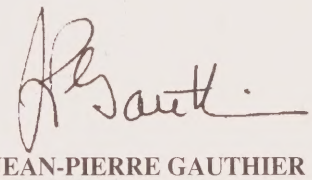

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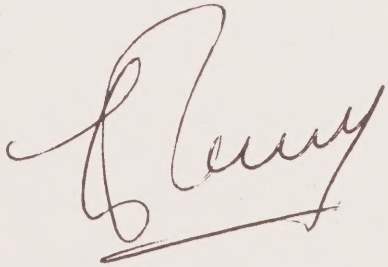

LAURENT TREMBLAY
Acting Director General
Parks Canada
Quebec Region

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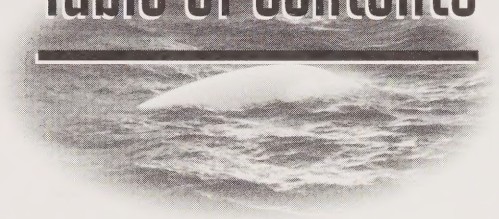
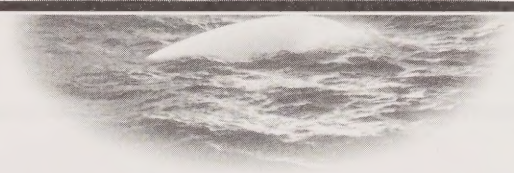


Favouring the survival of the St. Lawrence beluga



At the turn of the century, the population of St. Lawrence belugas was estimated at more than 5000 individuals, but a sharp decline reduced the population to a low of about 500 animals during the 1970s. The main cause of the decline was intensive hunting pressure, especially during the 1930s, encouraged by a fifteen dollar bounty granted to anyone bringing in beluga tail flukes.

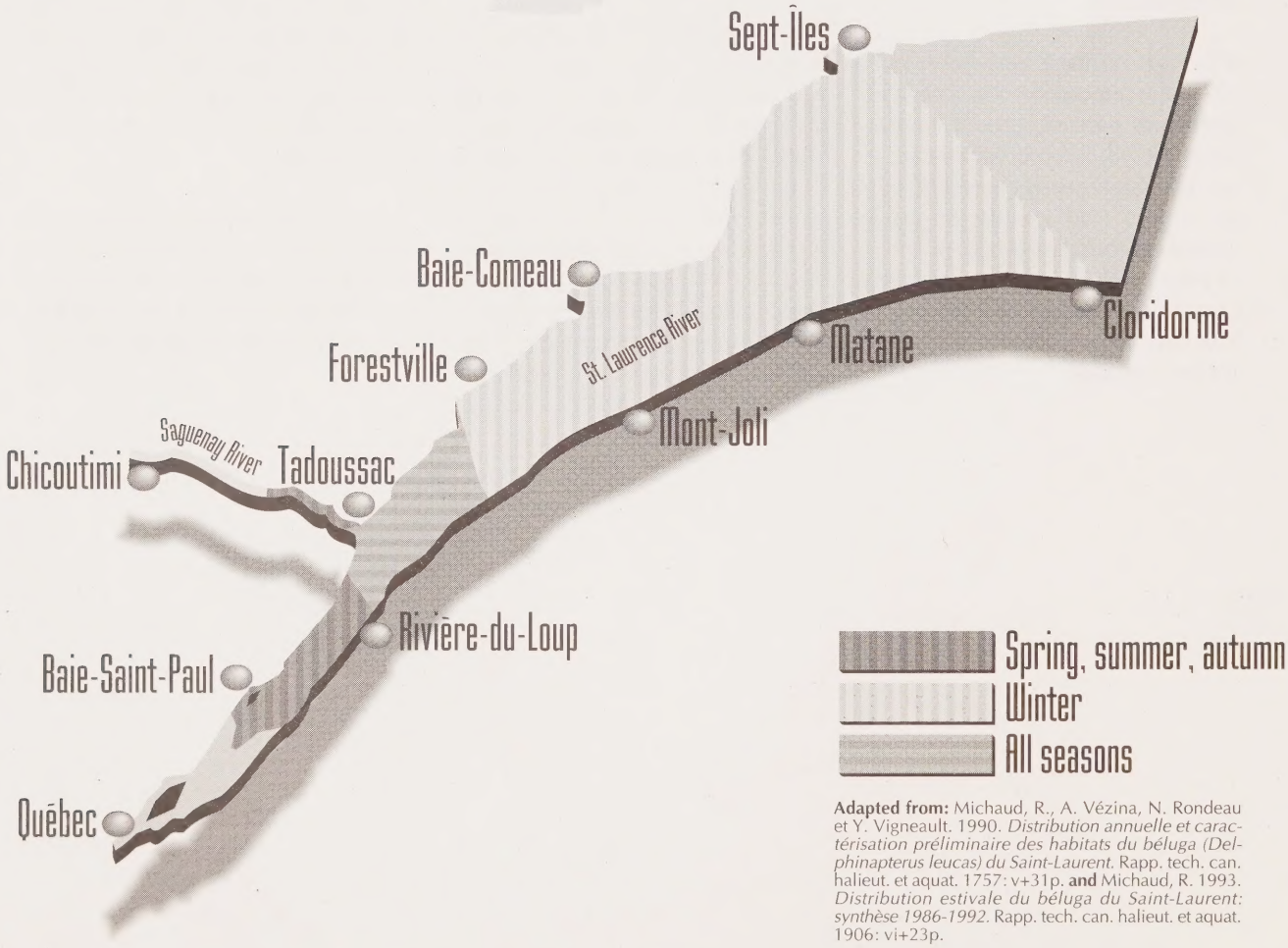
Although hunting was banned in 1978, the population has shown no significant signs of recovery; population growth is likely hampered, in part by disturbances caused by vessel traffic, and mostly by toxic substances found in its habitat and in its prey. Toxic substances, possibly causing cancer and other diseases, have been found in tissues of beached beluga carcasses.

The St. Lawrence harbours a distinct beluga population, which is totally isolated from populations in the Arctic Ocean and in James Bay and Hudson Bay. It is distributed in the estuary from east of Baie-Saint-Paul to Sept-Iles along the North Shore and to Cloridorme on the South Shore, and in the Saguenay River, from its mouth upstream to Saint-Fulgence, as shown in figure 1.

The St. Lawrence beluga is in such a precarious situation that in 1983, it was designated an endangered population by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Since then, major efforts have been made to promote the survival of this population. In 1986, at the initiative of the Department of Fisheries and Oceans, a federal interdepartmental committee was established, which resulted in the implementation of the Interdepartmental Action *Plan to Favour the Survival of the St. Lawrence Beluga* in June 1988. Since then the plan has been managed jointly by the Departments of Fisheries and Oceans and of Environment Canada within the framework of the *St. Lawrence Action Plan*. Under the Action Plan, several important research projects were conducted to gain knowledge on population trends, habitat use, the basic biology of the beluga, and the factors affecting population dynamics, in particular disturbance caused by vessel traffic and contamination by toxic substances.

This fifth annual report reviews the studies conducted during the 1992-1993 fiscal year, under the Interdepartmental Action *Plan to Favour the Survival of the St. Lawrence Beluga*.

Figure 1
Seasonal distribution of the St. Lawrence beluga



Adapted from: Michaud, R., A. Vézina, N. Rondeau et Y. Vigneault. 1990. *Distribution annuelle et caractérisation préliminaire des habitats du béluga (Delphinapterus leucas) du Saint-Laurent.* Rapp. tech. can. halieut. et aquat. 1757: v+31p. **and** Michaud, R. 1993. *Distribution estivale du béluga du Saint-Laurent: synthèse 1986-1992.* Rapp. tech. can. halieut. et aquat. 1906: vi+23p.

Increasing our knowledge

With the inception of the *Interdepartmental Action Plan to Favour the Survival of the St. Lawrence Beluga*, an extensive research program was initiated to improve the protection and conservation of the St. Lawrence beluga. Priorities for action can now be assigned; pooling of available data and new findings have increased our knowledge of population numbers, habitat use, distribution, population structure, and factors limiting population growth. Critical habitats to be protected or restored have been identified.

The St. Lawrence beluga population

Annual monitoring of population numbers, structure and distribution provides a measure of the effectiveness of actions taken for the recovery of the St. Lawrence beluga.

The beluga population

Despite a margin of error of more than 30%, aerial photographic surveys show that the population appears stable at about 460 to 540 individuals; population growth seems very slow.

A comparative study, conducted in 1990-1991, of the patterns of fragmentation of desoxyribonucleic acid (DNA), revealed that genetic variation within the St. Lawrence population is low, compared with the Beaufort Sea population. A similar comparison, conducted in 1992 with a different technique using mitochondrial DNA, indicates that the St. Lawrence belugas are more closely related to the Hudson Bay east coast population than to other arctic populations.

Population distribution

The annual distribution of the St. Lawrence beluga is shown in figure 1. Seasonal differences in range occur, related to varying ice conditions, feeding behaviour, calving and mating activities.

In order to more precisely determine the winter distribution, aerial surveys were carried out again in 1992. Moreover, in 1992, a detailed analysis was completed of surveys of summer distribution which had been carried out since 1986. This showed that during the summer, belugas are found mostly in the section of the estuary between Batture aux Loups Marins and Rivière Portneuf on the North Shore, and the Bic Islands on the South Shore, as well as in the Saguenay fiord, from its mouth to Saint-Fulgence. Thus, the summer distribution has been extended by about 30 kilometres beyond the downstream limit identified in previous studies.

Within the summer range, shown in figure 2, three sectors have been identified, that are used by pods of different age structures:

- from Baie-Saint-Paul to Tadoussac, pods include at least 30% juveniles;
- from the mouth of the Saguenay to Saint-Simon on the South Shore, the largest pods occur, regularly reaching 150 individuals or more. These are composed of adults only or adults with some juveniles;
- in the downstream portion of the range, pods are composed mostly of adults, with fewer than 10% juveniles.

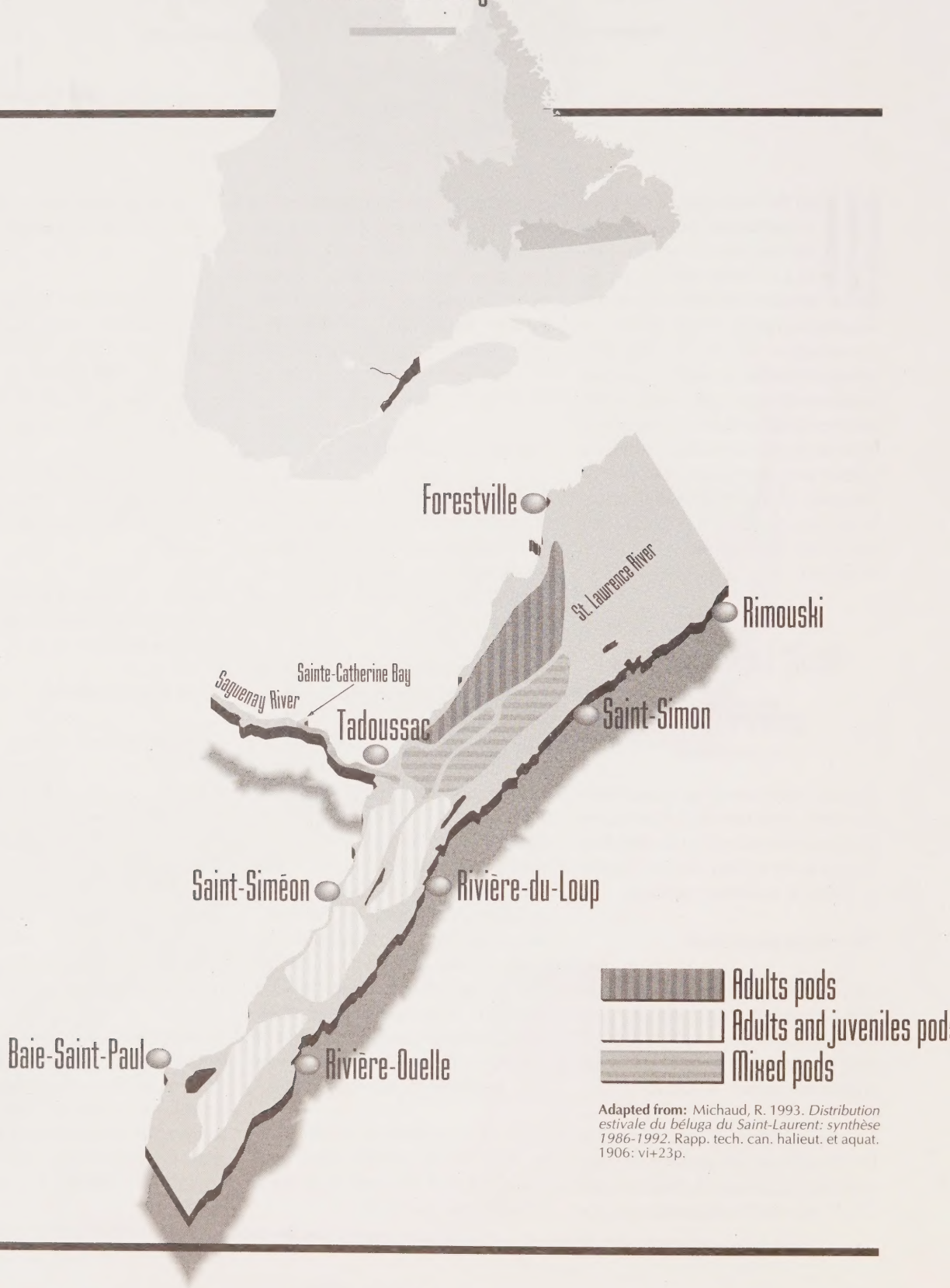
Finally, 18 zones of high frequency utilization have been identified within the three sectors.

Population structure

An agreement was signed between Fisheries and Oceans Canada (Maurice Lamontagne Institute), Environment Canada (Canadian Parks Service) and the St. Lawrence National Institute of Ecotoxicology, to conduct a study designed to assess the composition of the St. Lawrence beluga population and, more specifically, its social organization and population structure.

Several methods are used to analyse population dynamics. Aerial photographic surveys are consulted and patrols are conducted at sea to determine the proportion of calves (less than 1 year), juveniles (less than 7 years) and adults in each pod observed.

Figure 2
Summer distribution of the St. Lawrence beluga



Adapted from: Michaud, R. 1993. *Distribution estivale du béluga du Saint-Laurent: synthèse 1986-1992.* Rapp. tech. can. halieut. et aquat. 1906: vi+23p.

The age of beached belugas is determined by counting the growth rings on a tooth. However, this technique tends to underestimate the true age, especially of older animals, because of tooth wear. It is estimated that a beluga is mature at age 7 and may live, on average, an additional 13.6 years. However, this overall life expectancy of 20.6 years doesn't apply to the whole population because of juvenile mortality. Since 1992, serial sections of ovaries from beached females are made to monitor reproduction cycles.

Limiting factors

Population growth and dynamics of the St. Lawrence beluga are greatly influenced by stress and contamination, both factors acting on whale behaviour, movements and general health. Thus, accurate knowledge of these factors must be acquired in order to produce effective tools to reduce their impacts.

Stress

The analysis of vocalization patterns is a more sensitive and effective indicator of stress in the presence of ships and small craft than simple observation of the beluga's behaviour. The sound frequency of vocalizations, especially of whistles, varies significantly as a function of the noise produced by ship engines. These variations are further amplified when the animals are caught by surprise; for example, when an island or a point temporarily obstructs sound propagation. In these cases, the belugas switch from the spectrum of frequencies generally used to either very high or very low frequencies, less subject to interference.

Contaminants

The beluga is principally contaminated through the food it eats; concentrations of various contaminants vary according to its prey species. It seems that the American eel is the most contaminated of its prey. However, the situation may be improving; in a study of American eels at Kamouraska in 1990, it was found that concentrations of polychlorinated biphenyls (PCB) and Mirex had decreased respectively by 68 and 56%. Thus, the risk for belugas is lower. Also the eel population is currently decreasing.

Still, the analysis of tissues collected from 7 of 14 beluga carcasses beached in 1992 shows a level of contamination similar to that measured in previous years, with no significant increase or decrease. Contamination remains higher in St. Lawrence belugas than in Arctic belugas.

The high mortality rate and the low reproductive rate observed in the St. Lawrence population evidently result from the various internal lesions which themselves, seem to be associated with high concentrations of dichlorodiphenyltrichloroethane (DDT) and PCBs in tissues. The numerous scars and malformations, such as scoliosis and lordosis, are probably only a secondary cause of mortality.

Habitat conservation

In order to take appropriate protection measures, such as creating protected areas like the Saguenay Marine Park, it is essential to assess habitat losses and identify those habitats which are critical for the survival of the beluga. To this end, an integrated information system was elaborated and a thorough study of currents was undertaken.

The Integrated Information System on Fish Habitat Management (IISFHM)

In 1992, three projects contributed to the development of the IISFHM. First, a base map of the St. Lawrence system from Quebec city to Blanc-Sablon was produced in the SPANS geographic information system, jointly by the Fisheries and Habitat Management Branch and the Enforcement Branch of the Department of Fisheries and Oceans. Cod catches for 1992 were extracted from the Department's database and plotted on the map, providing a useful tool for the management of this species.

Second, a series of 13 maps was also produced, describing habitats in the middle estuary as a function of fish populations at risk. Finally, digital mapping of fisheries resources in the Chandler area (Baie des Chaleurs) was undertaken as a pilot project. A survey was conducted among fishermen to determine the distribution of commercial and sport-fishing species. Results were then digitized. These maps will serve as a basis for the development of sensitivity indexes for habitats in case of oil or chemical spills. Once the method has been tested, it can be applied to the St. Lawrence estuary in order to protect animal populations such as the beluga.

Current circulation

Three 3D water flow numerical models for currents induced by tide, winds or density gradient have been developed in order to understand the physical processes affecting the St. Lawrence between Trois-Rivières and Anticosti Island. These models

can be used in case of environmental emergencies, such as an oil slick, and to forecast the drift of fish larvae and of suspended particulate matter to which contaminants are linked.

Early results show that currents are faster and more complex in the middle estuary than in the lower estuary, where tidal influence is greater. In addition, a first integrated model on the dynamics of temperature and salinity is under development. It simulates and validates salinity and temperature gradients as a function of water-flow.

Controlling disturbances

Growth of the St. Lawrence beluga population is hampered in part by physical and acoustic disturbances. For example, the construction of marinas or wharves may alter critical habitats for feeding or nursing activities. It is recognized that all underwater sound can interfere with the communication system of the beluga. Thus, vessel traffic, whether freighters, liners, outboards and even sailboats, disturbs and frightens the belugas away, even when they are feeding, nursing or mating.

Small craft seem to have more impact than larger ones, given their high speed and greater manoeuvrability. Stress induced by these occurrences can well have direct consequences on the physiology and behaviour of the belugas.

Guidelines

At the annual meeting of the whale watching industry concerning the revision of whale watching guidelines, several suggestions were presented, in the form of a new code of ethics, to the Quebec Advisory Committee on St. Lawrence Cetaceans (QACSLC). Consequently, guidelines have been simplified and more emphasis given to actual regulations.

The new regulations on the protection of marine mammals were modified last February; paragraph 7 now reads: «No person shall disturb a marine mammal except when fishing for marine mammals under the authority of these Regulations». The minimum distance for approaching whales is maintained at 100 metres in the case of a single boat, and 200 metres, where several vessels are present; speed must still be reduced when approaching whales within 400 metres, and the ban on approaching belugas remains.

As every year since 1986, a preseason briefing session for everyone involved in the whale-watching industry (sailors, naturalists, etc.) was held to thoroughly review the whale-watching guidelines, so that the participants feel responsible for the protection of the species they exploit. This, in turn, promotes a form of self-regulation by the industry and encourages communication between the different companies, resulting in operations at sea which are better controlled and co-ordinated. This results in maintaining the excellent reputation of the Quebec whale-watching industry.

On going research projects on cetaceans are summarized at an evening information session, and the role played by the Department of Fisheries and Oceans in the protection of the St. Lawrence marine mammals is highlighted.

Finally, the participants are taken on a training cruise where approach techniques and distances under different conditions likely to occur are demonstrated. This activity is organized and presented in collaboration by the QACSLC, the GREMM (Marine Environment Education and Research Group), the Navimex whale-watching cruises and the Dufour family.

Also, for the third consecutive year, a visit was made of marinas and yacht clubs, in order to inform small craft owners about the whale-watching guidelines.

Surveillance

In 1992, the creation of a natural resources conservation unit in the Saguenay Marine Park resulted, among other things, in the addition of a team of park wardens. This made it possible to increase surveillance at sea and to develop new strategies for prevention and intervention in an environmental emergency, in order to protect marine resources and ecosystems, including beluga habitats.

A total of 236 hours of sea patrols were carried out in 1992, compared with 125 hours in 1991. An additional 42 hours was spent on the verification of ships in marinas. Two undercover operations were conducted in the Tadoussac and Rivière-du-Loup sectors, but no irregularities were observed. Altogether, the increased surveillance resulted in 19 court prosecutions, including three for disturbance of belugas; 27 complaints concerning harassment of marine

mammals in general, involving a total of 218 hours in investigation time.

Finally, an increase of scuba-diving activities in critical beluga habitats was observed.

Scientific research permits

Fifteen scientific research permits were issued in 1992; studies were conducted on blue whales, fin whales and belugas, and on grey seals and harbour seals. No irregularities were observed in the course of these research projects.

Reducing toxic substances

In order to promote the beluga's recovery, it is essential to identify toxic substances in its environment and to monitor contaminant flux from bottom sediments through the food chain up to fish species. Moreover, toxic waste disposal must be controlled in order to reduce the concentrations of toxic substances in the St. Lawrence River, and eventually in beluga tissues.

Contaminant flux in the beluga's food chain

Bioaccumulation of contaminants occurs in the beluga via two major access routes. First, as the last link in the food chain the beluga consumes several species of larger fish and invertebrates, which are contaminated. Second, marine worms such as nereis, although lower in the food chain, are also part of the beluga's diet; these worms live in bottom sediments where high concentrations of heavy metals are recorded. To understand the mechanisms of contamination in the beluga, the concentration of various substances at each level of the food chain must be determined.

Sediments

In the aquatic environment, contaminants tend to attach to particles of suspended matter which eventually deposit on the bottom. The concentration of contaminants in bottom sediments is a good indicator of global pollution, inclusive of all sources (atmosphere, tributaries, industrial or municipal sources). Sediment deposits can be dated by geochronological techniques, thus providing important information on contamination changes over time.

Several studies have investigated the accumulation of various contaminants in bottom sediments and the dynamics of sedimentation in the St. Lawrence River. One study evaluates the accumulation rates of heavy metals and organochlorines in sediments of the Laurentian Channel; another research project investigates the spatial distribution and the accumulation rate of organic contaminants in sediments, and evaluates the possibilities of contaminant recirculation in the water column.

The most recent results show that mercury deposits, accumulated in bottom sediments at depths in excess of 200 metres in the lower St. Lawrence estuary, which are directly attributable to human activity since the beginning of the industrial era, are in the order of 170 metric tons, plus or minus 50%. This is six times higher than the level of accumulation of mercury attributable to natural origins, over the same period of time.

Nevertheless, it was found that the rate of accumulation of mercury in sediments of the lower St. Lawrence estuary has decreased considerably since the beginning of the 1970s. This tendency is also observed for several other metals, including lead, zinc and copper.

It was also found that the concentration of mercury in sediments is much lower in the Gulf of St. Lawrence than in the lower estuary. A significant portion of the mercury deposited in these sediments is the result of pollutant transport through the atmosphere.

Contamination of sediments by organic contaminants such as PCBs and pesticides was found to be ten times lower in the lower St. Lawrence estuary than in the Great Lakes. Still, the mean accumulation rate of PCBs in the sediments of the lower estuary in the last decade is estimated at 450 kg per year. Among pesticides, DDT and its degradation products, and hexachlorobenzene (HCB) are the most abundant.

Finally, the research project on sedimentation dynamics in the stretch of the river between Cornwall and Trois-Rivières indicates a net accumulation of sediments at depths greater than 4.5 metres, with varying accumulation rates in the riverine lakes. However, the total amount of sediments accumulated each year is relatively small and represents only 6 to 8% of total suspended matter found near Trois-Rivières.

In fact, the transport of contaminants depends upon biophysical processes which occur in the active upper layer of sediments; the residence time of sediments in that layer was found to

be only about one year in Lake Saint-Louis, from 1.5 to 8 years in Lake Saint-François and about 1.4 years in Lake Saint-Pierre.

Concentrations of PCBs and of certain other contaminants were found to have decreased substantially in the sediments of Lake Saint-François and Lake Saint-Louis.On the other hand, a slight increase in trace metals such as cadmium, copper and zinc was recorded further downstream. In general, concentrations of trace metals in the upper layer of sediments often exceed quality criteria.

Phytoplankton, zooplankton and bacteria

These three trophic levels, representing various size classes of particulate matter, have been the subject of major research projects as part of a detailed investigation of assimilation and transport rates of several natural and man-made organic compounds, such as contaminants, in the food web of the St. Lawrence estuary. Results indicate that petroleum hydrocarbons and PAHs can be detected in significant concentrations in all size classes.

A decrease in concentration as a function of size was also noted at each sampling station, suggesting that there may be no bioaccumulation. However, caution is advisable in interpreting these findings since variations in the lipid/total weight ratio for various size classes were not taken into account. Since most organic contaminants accumulate mostly in lipids, this correction could modify the interpretation made of these preliminary results.

A linear decrease in the concentration of petroleum hydrocarbons and of polycyclic aromatic hydrocarbons (PAH) was also observed between the upstream and the downstream sections of the estuary, suggesting a greater contamination in the Quebec city area compared to the Saguenay and the lower estuary. In addition, significant seasonal variations in the concentrations of organic contaminants were recorded at all sampling stations, peaks being observed during spring runoff.

The St. Lawrence estuary is a brackish water ecosystem strongly influenced by continental rather than marine bacterial populations. Observations of significant concentrations of pathogenic and fecal coliform bacteria emphasize the need to locate the sources of bacterial pollution in the estuary; furthermore the possibility of survival in salt water of pathogenic bacteria such as salmonellas (Salmonella sp) should not be underestimated.

The study of bacteria, whether from cultured strains or not, can help to determine their enzymatic capacity, hence, their potential use in breaking down or assimilating contaminants. They may be more or less active, according to their size class, small (0.4 to 0.8µ) or large (0.8 to 1.2µ). It remains to be seen whether these two categories of bacteria can bind contaminants at the same rate; if such were the case, smaller cells, which are less active, could be subject to predation by microzooplankton, thus becoming a major exit route for contaminants.

Invertebrates and fish

Invertebrates and fish are situated at the trophic level immediately below the beluga; contaminant levels in these organisms are a good indicator of the toxic input they represent for the beluga. Accordingly, studies have been undertaken to identify toxic substances and to evaluate their toxicity in fish and benthic invertebrates of the St. Lawrence estuary and the Saguenay fiord.

One study bearing on American eels contaminated by chemicals in the Great Lakes attempted to assess toxic effects on the eels themselves, and to determine whether eels constitute the principal source of contaminants for belugas. A computer model of the accumulation of contaminants was developed; it shows clearly that the high levels of contaminants found in the belugas cannot be explained if eels are excluded from their diet. Concentrations of PCB, DDT and Mirex are much higher in eels than in other prey species of the beluga, such as herring and capelin.

Some researchers believe that half of the organochlorines found in beluga tissues come from eels migrating from the Great Lakes, where the fish have fed for years before maturing.

The incidence of malformations and of external pathologies is higher in eel populations found in the estuary than in eels from Rivière-aux-Pins, on the North Shore. Incidence of malformations increases with the duration of the migration period, in relation with an increase in the concentration of chemicals observed in late migrants. This could indicate that the occurrence of contaminants and of pathological conditions slows down migration or that eels from highly polluted areas have longer distances to cover, which is the case of eels migrating from the Great Lakes.

During an investigation carried out in a fish plant, the proportions of injuries, found to be low, and of malformations of the spine and of the fins of eels from various sites were determined. Histological examinations of livers revealed some precancerous lesions.

In addition, a marked decrease in young eels entering the St. Lawrence system has been noted. This was observed upriver as far as Cornwall, where young eels amounted in 1992

to only 2% of the numbers counted in 1985. It is difficult to establish a cause/effect relationship between contamination levels and the decrease in recruitment, because there is a lack of historical data on fishing and on the biology of the species; in addition there is no established correlation between the beginning of pollution in the St. Lawrence and the first signs of a population decrease.

Controlling toxic waste

Environmental toxicity is one of the limiting factors affecting the growth of the St. Lawrence beluga population; for this reason, the *St. Lawrence Action Plan* aims to substantially reduce the release of industrial toxic waste and designed an environmental emergency plan to preserve critical habitats in the St. Lawrence.

Reducing industrial pollution

The *St. Lawrence Action Plan* aims to reduce by 90% the toxic effluant discharged into the St. Lawrence and the Saguenay by the 50 most polluting industrial plants. Responsibility for achieving this goal has been given to the St. Lawrence Action Team, whose strategy is based upon the achievement of the six following objectives: the identification of the 50 most polluting industrial plants, the characterization of their effluent (49 of 50 achieved), the proposal of environmental objectives (48/50), the implementation of effluent quality standards (48/50), the pollution abatement measures (27/50) and, finally, the follow-up, to ensure that the results of effluent quality monitoring analyses comply with the quality standards and clean-up program as agreed by the plants (46/50).

Environmental emergencies

In the event of a maritime disaster, the Department of Fisheries and Oceans is involved in the emergency operations to ensure compliance with its mandate to protect and manage habitats, resources and fisheries. In 1992, assigned roles and responsibilities were restructured and redistributed among work groups which could be involved in the event of an environmental emergency; this resulted in the presentation of an updated version of the regional emergency plan.

Eight maritime incidents occurred in the Quebec Region during 1992, most involving oil spills either from a ship or from unidentified sources. Each case required the intervention of the Department of Fisheries and Oceans and the application of the regional emergency plan.

Over 228 twenty litre cans of various oil products were drifting in Diana Bay (northern Quebec); oil slicks were recorded between Sainte-Anne-de-la-Pérade and Grondines, as well as near Ile-aux-Coudres, at Bic and at Pointe Michel; oil spills occurred at Gros Cacouna Harbour and at MIL Davie in Levis; finally the derailment of a train at Cap Gribane in Charlevoix produced a minor spill.

Emergency drills were also conducted by Environment Canada: one drills simulated a collision between a container ship and a tanker at the entrance to the St. Lawrence canal (Montreal); a second one involved a simulated fire on a ship at Grande Anse in the Saguenay; a third exercise was held at Tadoussac in the course of a training workshop on environmental emergency measures.

In 1992-1993, representatives of the Department of Fisheries and Oceans participated in the Brander-Smith work group. Further to the public review of tanker safety and marine spills response capability, they initiated the implementation of recommendations made by the Brander-Smith panel on the application of contingency plans and on the identification and mapping of sensitive areas in the marine environment. As members of the steering committee, these same people participated in the preparation of a study on internal and external communications in environmental emergencies.

Communicating information

The goal of this theme of the Action Plan is to make scientific information accessible to all, and to develop public awareness of the problems which must be resolved in order to ensure the survival of the beluga, problems which all affect the quality of our own environment.

Communicating scientific information

Scientific information on the St. Lawrence beluga is released mostly in the form of scientific publications and reports, as well as through presentations at various conferences. A popular scientific document presenting the results of all the studies conducted by the Ecotoxicology and Ecosystems Branch of the St. Lawrence Centre is in production under the aegis of the *St. Lawrence Action Plan*; also a photographic library of 2600 transparencies documenting the bottom topography and animal life of the Saguenay fiord has been established, as well as a reference collection of the fiord's living organisms.

Scientific and technical publications

Scientific and technical publications present the results of studies conducted by research scientists of the Departments of Fisheries and Oceans and of the Environment, or by their collaborators. Several of these projects bear directly on the biology of the St. Lawrence beluga, including summer distribution, response to disturbances, pathology and toxicology. A list of the 1992-1993 publications is appended. An atlas showing the location of the major obstacles to the migration of eels in the St. Lawrence River has been prepared for the Department of Fisheries and Oceans.

Communications

Scientific presentations were made at various symposia describing the results of some of the on-going research projects pursued under the *St. Lawrence Action Plan* .

A presentation on the disturbance of the St. Lawrence beluga by vessel traffic was given at the 17th Conference of the Société Québecoise pour l'Etude Biologique du Comportement (SQEBC), held in Trois-Rivières in October 1992. During the same period, a conference was presented at the 19th annual workshop on aquatic toxicity held in Edmonton, on the development of a biotic integrity index using communities of benthic invertebrates.

Two presentations were made at the Canadian Conference on Fish and Fisheries Research (CCFFR), held in Peterborough in January 1993. One addressed the use of multiple function oxydase as an indicator of sub-lethal effects on fish in the natural environment, while the other addressed the contribution of Lake Ontario eel stocks to the contamination of the St. Lawrence beluga.

A workshop on the American eel was held in Ste-Foy, in March 1993, where three presentations were made on the contamination of eels from Lake Ontario and from the St. Lawrence estuary.

Finally, in 1993-1994, the major findings and results of research projects conducted under the *St. Lawrence Action Plan* were presented at the 61st Congress of the Association canadienne-française pour l'avancement des sciences (ACFAS), held in Rimouski from May 17-21, 1993.

Promoting public awareness

Promotion of public awareness requires various tools, including publications, educational computer software, information booths, expositions and visits to schools, marinas and summer camps to distribute brochures and other materials.

Publications

Publications in the form of newsletters, brochures, leaflets, factsheets or thematic maps are excellent ways of disseminating information and promote public awareness. More than 15,000 copies of these publications were distributed during the summer

of 1992, including a factsheet in the Underwater World series and the brochure *Watching Whales Without Harassment,* both dealing with the St. Lawrence beluga and cetaceans, and the newsletter *Beluga* which describes recent research and findings on the biology of the beluga. Three issues of this newsletter were published in 1992-1993.

In order to make the public aware of the precarious status of certain fish populations in the St. Lawrence estuary, a poster of these species was prepared and distributed. A map entitled «Summer distribution of the St. Lawrence Beluga» was also published.

Finally, the fourth annual reports of the *St. Lawrence Action Plan* and of the *Interdepartmental Action Plan to Favour the Survival of the St. Lawrence Beluga* were officially released on December 14 and 15 respectively.

Educational computer programs

The interactive educational computer programs Delphi and Navigator, respectively addressing beluga habitats and feeding habits, and guidelines for observing whales without harassment, were updated in 1992. The Navigator software was updated following changes to the regulations; it is now more interactive and will soon include a table listing the various species of marine mammals encountered in the estuary and the Gulf of St. Lawrence.

Information sessions

Several nature interpretation activities designed to promote public awareness of the threats to survival of the beluga, and other topics in the Saguenay Marine Park, were led by naturalists from the Canadian Parks Service and their partners. These took place at Pointe-Noire (with the assistance of the Quebec Linnean Society), and at Cap-de-Bon-Desir (with the help of the Corporation touristique de Bergeronnes and of l'Ecole de la Mer des jeunes explos).

Furthermore, naturalists from the Canadian Parks Service met with 1,790 6th grade students from schools in the Upper North Shore, Charlevoix and the Saguenay regions, in the course of regular school programs.

Visitors were initiated to the world of the St. Lawrence beluga at land-based observation sites, at interpretation centres with various exhibits, at temporary information booths, and through travelling exhibitions. Material displayed in the information booths included a whale skull, vertebrae and other whale bones. The Delphi and Navigator interactive educational programs were also presented in these booths.

The program to promote awareness among small craft owners and boaters was pursued in 1992 with visits to more than 30 marinas and summer camps; information was given on the guidelines to whale watching and on the precarious situation of the St. Lawrence beluga. This type of information was also presented in the course of 11 special events, such as boat shows.

Finally, information display booths were set up at the congress of the Association des biologistes du Québec (ABQ) and at the symposium Fleuves et Planète, to further disseminate information and promote awareness of projects carried out under the *St. Lawrence Action Plan* .

Publications appearing in 1992-1993

Increasing our knowledge

BÉLAND , P. S., S. De GUISE ET R. PLANTE. 1992. Toxicologie et pathologie des mammifères marins du Saint-Laurent. Programme d'Ecotoxicologie de la Faune. Fonds Mondial pour la Nature, Toronto. 100 p.

MICHAUD, R. 1993. La distribution de la population de bélugas du Saint-Laurent et la fréquentation des aires selon la composition des troupeaux. Rapport présenté au ministère des Pêches et des Océans et au Service canadien des parcs. Inst. Nat. Ecotoxicol. du Saint-Laurent.

MICHAUD, R. 1993. L'estimation du pourcentage de jeunes dans la population de bélugas du Saint-Laurent. Rapport présenté au ministère des Pêches et des Océans et au Service canadien des parcs. Inst. Nat. Ecotoxicol. du Saint-Laurent.

MICHAUD, R. 1993. Distribution estivale du béluga du Saint-Laurent; synthèse 1986 à 1992. Rapp. tech. can. sci. halieut. aquat. 1906: vi + 28 p.

Reducing toxic substances

COUILLARD, C.M., S. LECLERC, H. GILBERT, M. GRENIER et C. MITCHELL. 1992. Localisation des principaux obstacles à la migration des anguilles le long du fleuve Saint-Laurent. Atlas réalisé dans le cadre du Plan d'action Saint-Laurent pour le ministère des Pêches et des Océans, 28 p.

GEARING, J.N., J. TRONCZYNSKI et S.A. MACKO. 1992. Fluxes of anthropogenic and natural organic matter via particulates in the St. Lawrence Estuary. Presentation at the Joint ECSA / ERF Conference on changes in Fluxes in Estuaries. Implications from science to management. Plymouth, England, Sept. No 13018.

HODSON, P.V., C. DESJARDINS, É. PELLETIER, M. CASTONGUAY, R. McLEOD et C.M. COUILLARD. 1992. Baisse de la pollution chimique des anguilles capturées dans l'estuaire du Saint-Laurent. Rapp. tech. can. sci. halieut. aquat. 1876: 60 p.

HODSON, P.V. 1992. Toxicité des anguilles et leur transport de contaminants au béluga. Rapport réalisé dans le cadre du Plan d'action Saint-Laurent pour le ministère des Pêches et des Océans.

HODSON, P.V. 1992. Variations temporelles des pathologies des anguilles à Kamouraska. Rapport réalisé dans le cadre du Plan d'action Saint-Laurent pour le ministère des Pêches et des Océans.

HODSON, P.V. 1992. Contamination et toxicité chez les poissons et invertébrés benthiques de l'estuaire du Saint-Laurent et du Fjord du Saguenay. Rapport réalisé dans le cadre du Plan d'action Saint-Laurent pour le ministère des Pêches et des Océans.

Conclusion

During the five years of the *Interdepartmental Action Plan to Favour the Survival of the St. Lawrence Beluga*, various research projects resulted in increased knowledge of the beluga and of the whole St. Lawrence ecosystem. In turn, this resulted in more focussed efforts to eliminate or reduce those factors which are most likely to interfere with the beluga population and its habitat. Increased public awareness also played a major role, contributing to reducing man-made pollution and to influencing the various government levels to introduce more stringent regulations concerning toxic waste in the environment.

The first *Interdepartmental Action Plan to Favour the Survival of the St. Lawrence Beluga* thus ends on a positive note. Below we present the financial balance sheet for the 1992-1993 fiscal year, along with a summary of research findings and accomplishments. With the end of this action plan, the way is now clearly defined for further studies and efforts to ensure the survival of the beluga population and of the whole St. Lawrence river ecosystem.

Financial summary

The financial summary of the Interdepartmental Action Plan to Favour the Survival of the St. Lawrence Beluga presented in the following table, covers the period from April 1992 to March 1993. It shows the breakdown of funding by department, for each of the activities, as shared by the Department of Fisheries and Oceans and the Department of the Environment.

Summary of results

The major results obtained in 1992-1993 are presented under the four themes of the Action Plan.

Increasing our knowledge

The population of St. Lawrence beluga seems to remain stable at 500 individuals, with a very low growth

EXPENDITURES ALLOCATED TO THE ACTION PLAN

Themes	Expenditures ($)*			
	Fisheries and Oceans		Environment Canada	
	FHMB	RSB	CP	PS
Increasing our knowledge	290 000	136 000	0	20 000
Controlling disturbances	12 000		0	0
Reducing toxic substances	104 000	85 000	762 000	90 000
Communicating information	78 000		75 000	90 000
Total for 1992-1993	**484 000**	**221 000**	**837 000**	**125 000**

** **FHMB** : Fisheries and Habitat Management Branch • **RSB** : Regional Science Branch • **CP** : Conservation and Protection • **PS**: Parks Service*

rate. Genetically, the St. Lawrence belugas are more closely related to the Hudson Bay east coast population than to other arctic populations.

The summer range has been extended by 30% since the previous survey; summer critical habitats vary with the age of individuals. Groups of adults with juveniles are found mostly in the portion of the St. Lawrence estuary upstream from the Saguenay River, while the largest pods are seen below the Saguenay, consisting of mixed herds, either adults and juveniles or adults only.

Disturbances caused by underwater engine noises significantly modify the frequency of vocalizations, possibly to reduce interference with their communication system. An analysis of their sound producing behaviour could provide information on potential sources of disturbance.

Necropsies on beached carcasses indicate that the level of contamination in beluga tissues has been stable in recent years. Still, the high mortality and the low reproductive rate estimated for this population are possibly the result of internal lesions caused by high concentrations of DDT and PCBs, rather than the result of external injuries.

Three 3D numerical models of water circulation patterns induced by tide, wind or the density gradient are currently being developed to be used, among other purposes, in case of environmental disaster. Preliminary results indicate that currents are faster and more complex in the middle estuary than in the lower estuary, where tidal influence is greater.

Controlling disturbances

With the implementation of a natural resources conservation unit for the Saguenay Marine Park, sea patrols were stepped up during the summer of 1992 to 236 hours from 124 hours in 1991. An additional 218 hours were spent in investigation time. Fifteen scientific research permits were issued in 1992.

Reducing toxic substances

The mean accumulation rate of PCBs in the sediments of the lower estuary during the last decade is estimated at about 450 kg annually. The amount of mercury from human sources deposited in the sediments of the estuary during the industrial era is reckoned at 170 metric tons, six times more than the mercury load from natural sources. Mercury from human sources is mostly disseminated via the atmosphere.

Residence time of sediments in the active upper layer is about 1 year in Lake Saint-Louis and Lake Saint-Pierre, while it may reach 8 years in Lake Saint-François. In general, concentrations of heavy metals in these sediments exceed all quality criteria.

Bacteria may be an important output pathway for contaminants subject to predation by microzooplankton. In addition, pathogenic bacteria such as salmonellas (Salmonella sp.) may survive in saltwater.

The American eel has been shown to be the main potential source of contaminants for the beluga; eels from the Great Lakes population may contribute as much as 50% of the organochlorines found in belugas. However, it is difficult to establish a causal link between this contamination and the decrease in recruitment observed in the eel population.

In the course of reducing industrial pollution, the setting of environmental goals and of effluent quality standards has been completed for 48 of the 50 most polluting industrial plants; clean-up work has been completed for 27 plants.

Eight maritime incidents were recorded in the Quebec Region in 1992, most of them oil spills; in each case, the Department of Fisheries and Oceans intervened under its environmental emergency plan.

Communicating information

In 1992-1993, as in previous years, public awareness was promoted through visits to more than 30 marinas, several summer camps and schools and through participation in 11 special events. Displays were also presented in information booths and at exhibitions. Finally, 10 scientific reports and papers were published and seven conferences were given at various symposia.

Activities related to the Action Plan

Activities	Participating departments*			
	Fisheries and Oceans		Environment Canada	
	FHMB	RSB	CP	PS
INCREASING OUR KNOWLEDGE				
The St. Lawrence beluga population				
• The beluga population		●		●
• Population distribution	●	●		●
• Population structure		●		●
Limiting factors				
• Stress		●		●
• Contaminants	●	●		●
Habitat conservation				
• IISFHM	●			
• Current circulation	●	●		●
CONTROLLING DISTURBANCES				
• Guidelines	●			
• Surveillance	●			●
• Scientific research permits	●			
REDUCING TOXIC SUBSTANCES				
Contaminant flux in the beluga's food chain				●
• Sediments	●	●	●	●
• Phytoplankton, zooplankton and bacteria	●	●	●	●
• Invertebrates and fish	●	●	●	
Controlling toxic waste			●	
• Reducing industrial pollution	●	●	●	
• Environmental emergencies				●
COMMUNICATING INFORMATION				
Communicating scientific information				
• Scientific and technical publications	●	●	●	●
• Communications		●	●	
Promoting public awareness				
• Publications	●	●	●	●
• Educational computer programs	●		●	
• Information sessions	●		●	●

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